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IMPLEMENTATION AND DESIGN OF A SHALLOW WATER IMAGING SYSTEM

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LONG-TERM GOALS

Our long-term goal is to develop and improve acoustic techniques for imaging fine-scale stratigraphy in shallow-water environments Improved resolution of the preserved stratigraphy in shallow water regions is the necessary first step to determining the transfer functions between high-frequency sedimentary processes and the formation of the longer-term stratigraphic record. The dynamics linking physical processes operative on small spatial and temporal scales ("event" stratigraphy) to the formation of the longer-term stratigraphic record must be understood in order for us to construct realistic quantitative stratigraphic and morphologic models for shallow water regions.

SCIENTIFIC OBJECTIVES

Toward improved imaging capabilities of fine-scale stratigraphy, we are developing/modifying a Chirp side-scan sonar system (SUBSCAN) that will allow us to collect high resolution seismic data in littoral environments (surf zone to mid-shelf water depths). We are collaborating with researchers at Florida Atlantic University (FAU, Steve Shock), who pioneered the development of CHIRP technology and is spearheading the development of new acoustical techniques. The funds to design and implement the new SUBSCAN System were provided by both DURIP and ONR. The system will be portable, easily mobilized and available for use on research vessels of opportunity. Turn-key operations will enable researchers to acquire high-resolution seismic images across the littoral zone by providing advanced user-friendly software for automated data analysis.

APPROACH

We conducted several equipment demonstrations onboard the R/V Asterias and onshore in 1996 and 1997 (Elics, Klein, Ocean Acoustics, Datasonics & EdgeTech) to determine the imaging capabilities of the existing systems and ascertain which system was best suited for our proposed modifications.

ACCOMPLISHMENTS AND RESULTS

• Based on the equipment demonstrations and subsurface resolving capabilities, we purchased an EdgeTech SUBSCAN SB-0512 with dual frequency side-scan sonar (100/500 kHz) and accompanying MIDAS acquisition and processing software.
• We have conducted several additional expeditions onboard the R/V Asterias to further test the system and map subsurface channels in Vineyard and Nantucket Sounds.
• We are collaborating with Steve Shock from Florida Atlantic University, who is modifying the tranducers and receiving arrays in the SB-0512 fish to improve the imaging capability of the system. A shakedown cruise conducted in the Chesapeake Bay during the summer (1997) revealed that the new transducer configuration improved both subbottom penetration and resolution. Additional sea trials are planned for this fall/winter (Boca Raton).
• We are constructing a tow sled for the SB-0512 fish based on designs developed at Florida Atlantic University. Additional modifications to the SB-0512 acoustic shields will further reduce trapped multiples off the fish as well as sea-surface multiples. The towing frame, winch, and deployment system are designed for small research vessels and operation in high energy environments. The tow frame has been designed to be stable on the bottom while being towed slowly across the surf zone out to greater water depths. Outside the

surf zone the vehicle will be flown in a traditional configuration while maintaining a constant depth above the seafloor.
• We have entered into a collaborative agreement with EdgeTech to cost-share software and hardware modifications required to accommodate the necessary modification to the SB-0512 fish and topside software.
• A differential GPS and hydrographic survey system will be linked to the MIDAS topside software to acquire positional data with approximately 5 meter accuracy and provide helm guidance during the running of pre-defined survey lines.

SCIENTIFIC IMPACT

Determining the transfer functions between short term processes "event stratigraphy", the formation of the longer-term stratigraphic record, and the occurrence of seismic reflectors requires a multidisciplinary coordinated effort that brings together many disparate data sets (e.g., geological, geophysical, hydrodynamic, climatic, and historical data). Seismic systems operating at different frequencies reveal different reflection patterns, not only because higher-frequency systems have greater resolving capability, but also because reflections are often caused by complex interference patterns between closely-spaced stratigraphic horizons and outgoing signals. Consequently, multiple surveys with overlapping ranges of frequencies across the entire continental margin from the shoreline to the deep sea are needed to determine the origin of seismic reflectors, quantify reflection coefficients, and assess the spatial variability of reflectors. In order to determine how sedimentary sequences and their bounding unconformities are formed, it is imperative that we image sequences at resolutions consistent with the processes we are investigating. The dynamics linking physical processes to the formation of the longer-term stratigraphic record must be understood in order for us to construct realistic quantitative stratigraphic and morphologic models for shallow water regions.

TRANSITIONS

The new SUBSCAN System will be used as part of a STRATAFORM cruise off the Eel River in July of 1998 onboard the R/V Wecoma (Nittrouer). In addition, the new system will be used to map the morphology and fine-scale stratigraphy of the shallow water region (<65 m) surrounding the Eel River, California to define the spatial and temporal variability of the Eel River subaqueous delta and to determine its relationship to the surrounding shallow water regions and mid-shelf fine-grained flood deposits (August, 1998). Finally, the data acquired during the SB-0512 sea trials in Vineyard and Nantucket Sound are being used as part of a Ph.D. thesis (B. Gutierrez).

RELATED PROJECTS

The goals of this project interface with the objectives of a number of ongoing and proposed research projects within the ONR STRATAFORM Initiative both on the east and west coast of the United States. Furthermore, understanding the processes that transfer sediment, sculpt the continental margin, and create stratigraphic sequences can lead to predictive quantitative models of bottom morphology, acoustic character, stratal architecture, and facies distribution that can be applied to other littoral zones throughout the world.